

11
11
434
26
2

THE HEALTH CONSEQUENCES OF SMOKING

CANCER AND CHRONIC LUNG DISEASE IN THE WORKPLACE

a report of the Surgeon General



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Office on Smoking and Health
Rockville, Maryland 20857

THE HEALTH CONSEQUENCES OF SMOKING

CANCER AND CHRONIC LUNG DISEASE IN THE WORKPLACE

a report of the Surgeon General

1985



U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Office on Smoking and Health
Rockville, Maryland 20857



THE SECRETARY OF HEALTH AND HUMAN SERVICES
WASHINGTON, D.C. 20201

MAY 8 1968

The Honorable Thomas P. O'Neill, Jr.
Speaker of the House of Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

It is a pleasure to transmit to the Congress the final edition of the Surgeon General's Report on the Health Consequences of Smoking, as mandated by Section 8(a) of the Public Health Cigarette Smoking Act of 1969. This is the Public Health Service's 17th Report on this topic and, like earlier Reports, identifies cigarette smoking as one of this Nation's most serious public health problems.

This Report, which provides a detailed review of the relationship between smoking and hazardous substances in the workplace, is particularly disturbing because of the added health burden that many workers carry if they smoke cigarettes. As this Report makes clear, for some workers this added burden is substantial. No better example exists to illustrate this interaction than the case of asbestos workers. Current scientific evidence indicates that heavily exposed asbestos insulation workers who did not smoke may experience a 5-fold increase in lung cancer compared to nonsmoking, nonexposed workers. However, if this same worker also smoked, his lung cancer risk is increased more than 50-fold.

Also disturbing is the continued high rate of current cigarette use among blue collar workers compared to their white collar counterparts. These workers are more apt to be exposed to dusts and other harmful substances in their workplace environments. Programs to reduce workplace hazardous exposures are helping to offset these risks. For the majority of workers who smoke, cigarette smoking poses a greater risk to health than does occupational exposure. Thus, elimination of cigarette smoking among such workers can have a profound effect on improving their health.

This Department has a strong commitment to prevention and health promotion. It is essential that workplace health promotion programs have a strong focus on reducing cigarette smoking among employees to the extent possible. These efforts can not only have an effect on the health of the individual, but may also have a substantial impact by reducing absenteeism on the job, thereby improving productivity and reducing health care costs.

Cigarette smoking is associated with an estimated \$23 billion in health care costs annually and over \$30 billion in lost productivity and wages. To a certain degree we all share these costs whether we smoke or not. Programs that reduce smoking, therefore, can have a benefit to all our society.

Sincerely,

Otis R. Bowen, M.D.
Secretary

Enclosure



THE SECRETARY OF HEALTH AND HUMAN SERVICES
WASHINGTON, D.C. 20201

MAY 1 1986

The Honorable George Bush
President of the Senate
Washington, D.C. 20510

Dear Mr. President:

It is a pleasure to transmit to the Congress the final edition of the Surgeon General's Report on the Health Consequences of Smoking, as mandated by Section 8(a) of the Public Health Cigarette Smoking Act of 1969. This is the Public Health Service's 17th Report on this topic and, like earlier Reports, identifies cigarette smoking as one of this Nation's most serious public health problems.

This Report, which provides a detailed review of the relationship between smoking and hazardous substances in the workplace, is particularly disturbing because of the added health burden that many workers carry if they smoke cigarettes. As this Report makes clear, for some workers this added burden is substantial. No better example exists to illustrate this interaction than the case of asbestos workers. Current scientific evidence indicates that heavily exposed asbestos insulation workers who did not smoke may experience a 5-fold increase in lung cancer compared to nonsmoking, nonexposed workers. However, if this same worker also smoked, his lung cancer risk is increased more than 50-fold.

Also disturbing is the continued high rate of current cigarette use among blue collar workers compared to their white collar counterparts. These workers are more apt to be exposed to dusts and other harmful substances in their workplace environments. Programs to reduce workplace hazardous exposures are helping to offset these risks. For the majority of workers who smoke, cigarette smoking poses a greater risk to health than does occupational exposure. Thus, elimination of cigarette smoking among such workers can have a profound effect on improving their health.

This Department has a strong commitment to prevention and health promotion. It is essential that workplace health promotion programs have a strong focus on reducing cigarette smoking among employees to the extent possible. These efforts can not only have an effect on the health of the individual, but may also have a substantial impact by reducing absenteeism on the job, thereby improving productivity and reducing health care costs.

Cigarette smoking is associated with an estimated \$23 billion in health care costs annually and over \$30 billion in lost productivity and wages. To a certain degree we all share these costs whether we smoke or not. Programs that reduce smoking, therefore, can have a benefit to all our society.

Sincerely,

Otis R. Bowen, M.D.
Secretary

Enclosure

FOREWORD

Over the past generation, the actions of labor unions, management, insurers, and Government have made substantial progress in reducing exposure to hazardous substances in the workplace. This Report acknowledges this progress, and demonstrates clearly that these efforts to protect the American worker must continue. There can be no relaxation in our efforts to continue the safeguards already in place or to seek new safeguards as new hazards are identified.

This Report also establishes that for these efforts to protect the worker to fully succeed, these same forces of labor, management, insurers, and Government must become equally engaged in attempts to reduce the prevalence of cigarette smoking, particularly among those working populations most at risk. For the majority of workers who smoke, cigarette smoking poses a greater risk to health than does occupational exposure.

This 1985 Report of the Surgeon General examines in greater depth than ever before the relationships between cigarette smoking and occupational exposures; it is a document of singular importance. As with previous Reports, a large number of experts and scientists recruited from both within and outside the Federal service have participated in developing and reviewing the content of this Report. I express here my respect and gratitude for their efforts.

Donald Ian Macdonald, M.D.
Acting Assistant Secretary
for Health

PREFACE

The 1985 Report on the Health Consequences of Smoking presents a comprehensive review of the interaction of cigarette smoking with occupational exposures in the production of cancer and chronic lung disease.

Cigarette smoking and its relationship to cancer and chronic obstructive lung disease (COLD) were extensively reviewed in the 1982 and 1984 Surgeon General's Reports, respectively. In the 1982 Report, cigarette smoking was judged to be the leading cause of cancer mortality in the United States; a causal association was found between smoking and cancer of the lung, larynx, oral cavity, and esophagus, and smoking was identified as a contributory factor in the development of cancer of the bladder, kidney, and pancreas. In 1984, cigarette smoking was identified as the major cause of COLD, which includes chronic bronchitis and emphysema, among both men and women in the United States. The contribution of other factors in COLD morbidity and mortality was found to be far less important than that of cigarette smoking.

This Report examines the evidence available on the role played by cigarette smoking and occupational exposure in the development of cancer and chronic lung disease. Cancer and chronic lung disease are major causes of death in the United States, accounting for well over 25 percent of all deaths annually. Cancer mortality rates have shown a steady increase, unlike rates for the major cardiovascular diseases, which have declined over the last two decades. Chronic lung disease, now the fifth leading cause of mortality, has been increasing more rapidly than other major causes of death. It is estimated that more than 10 million Americans report suffering from these diseases.

Findings of the 1985 Report

The major overall conclusions of this Report are these:

For the majority of American workers who smoke, cigarette smoking represents a greater cause of death and disability than their workplace environment.

In those worksites where well-established disease outcomes occur, smoking control and reduction in exposure to hazardous agents are effective, compatible, and occasionally synergistic

approaches to the reduction of disease risk for the individual worker.

Smoking and occupational exposures can interact synergistically to create more disease than the sum of the separate exposures. This kind of interaction is exemplified by the relationship between asbestos exposure and smoking. A study of heavily exposed asbestos insulation workers, more than 20 years after onset of exposure, demonstrated a fivefold increased risk for lung cancer among nonsmoking asbestos workers compared with nonsmokers without asbestos exposure. We know that in non-asbestos-exposed populations, smoking increases the lung cancer risk approximately tenfold. The risk is increased more than fiftyfold if the asbestos workers also smoke. This risk in cigarette-smoking asbestos workers is greater than the sum of the risk of the independent exposures, and is approximated by multiplying the risks of the two separate exposures. In other words, for those workers who both smoke and are exposed to asbestos, the risk of developing and dying from lung cancer is 5,000 percent greater than the risk for individuals who neither smoke nor are exposed. Thus, the interaction of cigarette smoking and asbestos exposure is multiplicative. For asbestos workers, the risk of developing and dying of lung cancer increases with an increasing number of cigarettes smoked per day and with an increasing asbestos exposure. For example, the risk is 87 times greater for those workers who smoke more than one pack per day. The risk declines among workers who are able to stop smoking, compared with the risk for those who continue to smoke. An interaction for the production of lung cancer also exists between cigarette smoking and the radon daughters exposure of miners, although the exact nature of this interaction is not clear.

Both cigarette smoking and exposure to certain occupational hazards increase the risk for chronic lung disease. These risks can occur independently or may combine to produce a greater degree of lung injury than would have occurred from either exposure separately. While many exposures are capable of producing chronic lung injury, either independently or in combination, smoking appears to be the more important exposure for the majority of U.S. workers.

Differences in Smoking Behavior Between White-Collar Workers and Blue-Collar Workers

This Report also presents detailed findings with regard to differences in smoking prevalence between blue-collar workers and white-collar workers. Blue-collar workers are more likely to be exposed to workplace agents, which, in combination with their higher smoking rates, may place these workers at considerable excess risk for cancer

and chronic lung disease. Although these differences exist among both men and women, they are more pronounced among men.

The differences in the prevalence of smoking between blue-collar workers and white-collar workers may underestimate the differences found among specific populations of occupationally exposed workers. As noted in this Report, individual studies among certain workers report current smoking rates well in excess of 50 percent. In addition, in one of the largest studies of asbestos workers, more than 80 percent of the men in the cohort had been regular cigarette smokers during their lifetime and only 11 percent were classified as never having smoked regularly. These differences in smoking behavior make the control for smoking behavior an important part of the design of studies of the relationship of occupational exposures and cancer or chronic lung disease.

On the average, blue-collar men initiate smoking approximately 14 months earlier than white-collar men. We know from existing studies that an earlier age of initiation is strongly correlated with increased mortality for lung cancer and chronic lung disease as well as for most other smoking-related diseases. Even with this earlier age of initiation, a substantial fraction of blue-collar workers begin smoking coincident with their entry into the workforce, and blue-collar workers are less likely than white-collar workers to be able to successfully quit smoking.

Smoking Control in the Workplace

The potential role of the workplace in promoting initiation and fostering the continuation of smoking behavior represents a kind of interaction between smoking and the workplace that may affect large numbers of U.S. workers. It seems clear that the responsibility for health in the workplace includes at minimum a work environment that does not promote smoking or interfere with cessation.

The worksite offers an opportunity for implementation of smoking cessation programs. A number of studies cited in this Report found worksite-based programs to be more successful than clinic-based programs, probably owing to their more intensive nature and because many employer-sponsored programs offer economic and other incentives, thus enhancing their success.

The goal in public health, both in the worksite and outside it, is the reduction and elimination of disease and the promotion of healthy behavior. The content of this Report makes it clear that the elimination of chronic lung disease and cancer from the workplace cannot succeed without a companion effort to alter the smoking behavior of workers. It is precisely those occupations in which the greatest occupational hazards have existed that smoking cessation also yields the greatest return for individual worker's health. It

should be obvious that smoking cessation efforts are an adjunct to, and not a substitute for, occupational environmental controls. Correspondingly, a concern about workers' health that limits itself to the control of environmental exposure levels disregards the major health benefits of smoking cessation.

C. Everett Koop, M.D.
Surgeon General

ACKNOWLEDGMENTS

This Report was prepared by the U.S. Department of Health and Human Services under the general editorship of the Office on Smoking and Health, Donald R. Shopland, Acting Director. Managing Editor was William R. Lynn, Acting Technical Information Officer, Office on Smoking and Health.

Senior scientific editor was David M. Burns, M.D., Associate Professor of Medicine, Division of Pulmonary and Critical Care Medicine, University of California at San Diego, San Diego, California. Consulting scientific editors were Ellen R. Gritz, Ph.D., Associate Director for Research, Division of Cancer Control, Jonsson Comprehensive Cancer Center, University of California at Los Angeles, Los Angeles, California; John H. Holbrook, M.D., Associate Professor of Internal Medicine, University of Utah Medical Center, Salt Lake City, Utah; and Jonathan M. Samet, M.D., Associate Professor of Medicine, Department of Medicine, The University of New Mexico School of Medicine, Albuquerque, New Mexico.

The following individuals prepared draft chapters or portions of the Report.

Victor E. Archer, M.D., Clinical Professor, Rocky Mountain Center for Occupational and Environmental Health, The University of Utah Medical Center, Salt Lake City, Utah

Michael E. Baser, M.S., Chief, Occupational Health, Bureau of Environmental Epidemiology and Occupational Health, New York State Health Department, Albany, New York

David M. Burns, M.D., Associate Professor of Medicine, Division of Pulmonary and Critical Care Medicine, University of California at San Diego, San Diego, California

David B. Coultas, M.D., Instructor of Medicine, Department of Medicine and the New Mexico Tumor Registry, The University of New Mexico School of Medicine, Albuquerque, New Mexico

John E. Craighead, M.D., Professor and Chairman, Department of Pathology, The University of Vermont College of Medicine, Burlington, Vermont

Lori A. Crane, M.P.H., Staff Research Associate, Division of Cancer Control, Jonsson Comprehensive Cancer Center, University of California at Los Angeles, Los Angeles, California

Philip E. Enterline, Ph.D., Department of Biostatistics, University of Pittsburgh Graduate School of Public Health, Pittsburgh, Pennsylvania

Russell E. Glasgow, Ph.D., Research Scientist, Oregon Research Institute, Eugene, Oregon

David F. Goldsmith, Ph.D., Visiting Assistant Professor, Department of Internal Medicine, School of Medicine, University of California at Davis, Davis, California

Robert C. Klesges, Ph.D., Associate Professor, Center for Applied Psychological Research, Department of Psychology, Memphis State University, Memphis, Tennessee

Alfred C. Marcus, Ph.D., Program Director for Evaluation, Division of Cancer Control, Jonsson Comprehensive Cancer Center, University of California at Los Angeles, Los Angeles, California

Steven Markowitz, M.D., Environmental Sciences Laboratory, Department of Community Medicine, The Mount Sinai Medical Center, The Mount Sinai School of Medicine of the City University of New York, New York, New York

James A. Merchant, M.D., Dr.P.H., Professor of Preventive and Internal Medicine, and Director, Institute of Agricultural Medicine and Occupational Health, The University of Iowa College of Medicine, Iowa City, Iowa

Albert Miller, M.D., Clinical Professor of Medicine (Pulmonary), Clinical Professor of Community Medicine (Environmental), and Director, Pulmonary Function Laboratory, Division of Pulmonary Medicine, Department of Internal Medicine, The Mount Sinai Medical Center, The Mount Sinai School of Medicine of the City University of New York, New York, New York

Donald P. Morgan, M.D., Ph.D., Professor, Department of Preventive Medicine and Environmental Health, The University of Iowa College of Medicine, Iowa City, Iowa

W.K.C. Morgan, M.D., F.R.C.P.(Ed), F.R.C.P.(C), F.A.C.P., Chest Diseases Unit, University Hospital, London, Ontario, Canada

Brooke T. Mossman, Ph.D., Associate Professor of Pathology, and Chairman, Cell Biology Program, Department of Pathology, The University of Vermont College of Medicine, Burlington, Vermont

Paul R. Pomrehn, Jr., M.D., Assistant Professor, Department of Preventive Medicine and Environmental Health, and Director, University Occupational Health Service, The University of Iowa College of Medicine, Iowa City, Iowa

Howard E. Rockette, Ph.D., Professor of Biostatistics, Department of Biostatistics, University of Pittsburgh Graduate School of Public Health, Pittsburgh, Pennsylvania

Jonathan M. Samet, M.D., M.S., Associate Professor of Medicine, Department of Medicine, The University of New Mexico School of Medicine, Albuquerque, New Mexico

Cecilia M. Smith, M.D., Assistant Professor of Medicine, Division of Pulmonary and Critical Care Medicine, University of California at San Diego, San Diego, California

Melvyn S. Tockman, M.D., Ph.D., Associate Professor of Environmental Health Sciences, with joint appointments in Respiratory Medicine and Epidemiology, Center for Occupational and Environmental Health, The Johns Hopkins University, Baltimore, Maryland

Pamela H. Wolf, Dr.P.H., Biostatistician, Contraceptive Evaluation Branch, Center for Population Research, National Institute of Child Health and Human Development, National Institutes of Health, Bethesda, Maryland

The editors acknowledge with gratitude the following distinguished scientists, physicians, and others who lent their support in the development of this Report by coordinating manuscript preparation, contributing critical reviews of the manuscript, or assisting in other ways.

Charles A. Althafer, Assistant Director for Health Promotion and Risk Appraisal, Office of Program Planning and Evaluation, National Institute for Occupational Safety and Health, Centers for Disease Control, Atlanta, Georgia

Harlan E. Amandus, Ph.D., Statistician, Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, West Virginia

Stephen M. Ayres, M.D., Dean, School of Medicine, Medical College of Virginia, Richmond, Virginia

Mary A. Ballew, M.S., Epidemiologist, Document Development Branch, Division of Standards Development and Technology Transfer, National Institute for Occupational Safety and Health, Centers for Disease Control, Cincinnati, Ohio

Margaret R. Becklake, M.D., Professor, Departments of Medicine, Epidemiology, and Biostatistics, McGill University, Montreal, Quebec, Canada, on sabbatical, and Career Investigator, Medical Research Council of Canada, Montreal, Quebec, Canada, on leave; Professor (Honorary), Department of Community Health, University of the Witwatersrand, and Principal Medical Officer, National Centre for Occupational Health, Department of Health and Welfare, Johannesburg, South Africa

Kenneth R. Berger, M.D., Ph.D., Adjunct Assistant Professor, Epidemiology and Preventive Medicine, University of Maryland School of Medicine, Baltimore, Maryland

Robert Bernstein, Senior Reviewer, Document Development Branch, Division of Standards Development and Technology Transfer, National Institute for Occupational Safety and Health, Centers for Disease Control, Cincinnati, Ohio

Donald B. Bishop, Ph.D., Research Associate, Department of Psychology, Washington University in St. Louis, St. Louis, Missouri

Brian A. Boehlecke, M.D., M.P.H., Associate Professor of Medicine, Division of Pulmonary Diseases, Critical Care and Occupational Medicine, Department of Medicine, School of Medicine, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina

Lester Breslow, M.D., M.P.H., Co-Director, Division of Cancer Control, Jonsson Comprehensive Cancer Center, University of California at Los Angeles, Los Angeles, California

Benjamin Burrows, M.D., Professor of Internal Medicine, and Director, Division of Respiratory Sciences, The University of Arizona College of Medicine, Tucson, Arizona

Robert M. Castellan, M.D., Chief, Clinical Section, Clinical Investigations Branch, Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, West Virginia

John E. Davies, M.D., M.P.H., Professor and Chairman, Department of Epidemiology and Public Health, University of Miami School of Medicine, Miami, Florida

Vincent T. DeVita, Jr., M.D., Director, National Cancer Institute, National Institutes of Health, Bethesda, Maryland

John E. Diem, Ph.D., Professor of Statistics, Tulane University, New Orleans, Louisiana

Manning Feinleib, M.D., Dr.P.H., Director, National Center for Health Statistics, Office of the Assistant Secretary for Health, Hyattsville, Maryland

Edwin B. Fisher, Jr., Ph.D., Associate Professor of Psychology and Preventive Medicine, Department of Psychology, Washington University in St. Louis, St. Louis, Missouri

Lawrence Garfinkel, M.A., Vice President for Epidemiology and Statistics, and Director of Cancer Prevention, American Cancer Society, Incorporated, New York, New York

J.C. Gilson, M.D., Hembury Hill Farm, Honiton, Devon, England, United Kingdom

William E. Halperin, M.D., M.P.H., Chief, Industrywide Studies Branch, Division of Surveillance Hazard Evaluations and Field Studies, National Institute for Occupational Safety and Health, Centers for Disease Control, Cincinnati, Ohio

Peter V.V. Hamill, M.D., M.P.H., Adjunct Professor, Epidemiology and Preventive Medicine, University of Maryland School of Medicine, Baltimore, Maryland

John L. Hankinson, Ph.D., Chief, Clinical Investigations Branch, Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health, Centers for Disease Control, Morgantown, West Virginia

Naomi Harley, Ph.D., Professor, Institute of Environmental Medicine, New York University Medical Center, New York, New York

Wayland J. Hayes, Jr., M.D., Ph.D., Professor Emeritus of Biochemistry (Toxicology), School of Medicine, Vanderbilt University, Nashville, Tennessee

Ian T.T. Higgins, M.D., Professor Emeritus of Epidemiology and of Environmental and Industrial Health, School of Public Health, The University of Michigan, Ann Arbor, Michigan, and Acting Chief of Epidemiology, American Health Foundation, New York, New York

Thomas K. Hodous, M.D., Medical Officer, Clinical Investigations Branch, Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health, Centers for Disease Control, and Adjunct Associate Professor, West Virginia University School of Medicine, Morgantown, West Virginia

Michael Jacobsen, Ph.D., Deputy Director, Institute for Occupational Medicine, Edinburgh, Scotland, United Kingdom

Robert N. Jones, M.D., Professor of Medicine, Pulmonary Diseases Section, Department of Medicine, Tulane University School of Medicine, New Orleans, Louisiana

Marcus M. Key, M.D., Professor of Occupational Medicine, Program in Occupational Safety and Health, School of Public Health, University of Texas Health Science Center at Houston, Houston, Texas

Kaye H. Kilburn, M.D., Ralph Edgington Professor of Medicine, Laboratory for Environmental Sciences, University of Southern California School of Medicine, Los Angeles, California

Arthur M. Langer, Ph.D., Associate Professor of Mineralogy, The Mount Sinai School of Medicine of the City University of New York, New York, New York

N. LeRoy Lapp, M.D., Professor of Medicine, Pulmonary Disease Section, West Virginia University Medical Center, Morgantown, West Virginia

Richard A. Lemen, Director, Division of Standards Development and Technology Transfer, National Institute for Occupational Safety and Health, Centers for Disease Control, Cincinnati, Ohio

Claude Lenfant, M.D., Director, National Heart, Lung, and Blood Institute, National Institutes of Health, Bethesda, Maryland

Trent R. Lewis, Ph.D., Chief, Experimental Toxicology Branch, Division of Biomedical and Behavioral Science, National Institute for Occupational Safety and Health, Centers for Disease Control, Cincinnati, Ohio

Edward Lichtenstein, Ph.D., Professor of Psychology, University of Oregon, and Research Scientist, Oregon Research Institute, Eugene, Oregon

- Ruth Lilis, M.D., Professor, Division of Environmental and Occupational Medicine, Department of Community Medicine, The Mount Sinai School of Medicine of the City University of New York, New York, New York
- Jay H. Lubin, Ph.D., Health Statistician, Biostatistics Branch, Division of Cancer Etiology, National Cancer Institute, National Institutes of Health, Bethesda, Maryland
- James O. Mason, M.D., former Acting Assistant Secretary for Health, Washington, D.C., and Director, Centers for Disease Control, Atlanta, Georgia
- J. Corbett McDonald, M.D., F.R.C.P., Professor, School of Occupational Health, McGill University, Montreal, Quebec, Canada
- J. Michael McGinnis, M.D., Deputy Assistant Secretary for Health (Disease Prevention and Health Promotion), Office of the Assistant Secretary for Health, Washington, D.C.
- J. Donald Millar, M.D., Assistant Surgeon General and Director, National Institute for Occupational Safety and Health, Centers for Disease Control, Atlanta, Georgia
- Anthony B. Miller, M.B., F.R.C.P.(C), Director, Epidemiology Unit, National Cancer Institute of Canada, and Professor of Preventive Medicine and Biostatistics, University of Toronto, Toronto, Ontario, Canada
- Kenneth M. Moser, M.D., Professor of Medicine, School of Medicine, University of California at San Diego, La Jolla, California, and Director, Division of Pulmonary and Critical Care Medicine, University of California Medical Center, San Diego, California
- Robert J. Mullan, M.D., Medical Officer, Surveillance Branch, Division of Surveillance Hazard Evaluations and Field Studies, National Institute for Occupational Safety and Health, Centers for Disease Control, Cincinnati, Ohio
- Muriel Newhouse, M.D., F.R.C.P., Department of Occupational Health and Applied Physiology, London School of Hygiene and Tropical Medicine, University of London, London, England, United Kingdom
- William J. Nicholson, Ph.D., Associate Professor, Division of Environmental and Occupational Medicine, Department of Community Medicine, The Mount Sinai School of Medicine of the City University of New York, New York, New York
- Judith K. Ockene, Ph.D., Associate Professor of Medicine, and Director, Division of Preventive and Behavioral Medicine, Department of Medicine, University of Massachusetts Medical School, Worcester, Massachusetts
- C. Tracy Orleans, Ph.D., Clinical Assistant Professor, University of Pennsylvania Medical School, Philadelphia, Pennsylvania; Smoking and Health Consultants, Incorporated, Princeton, New Jersey

Carl E. Ortmeier, Ph.D., Public Health Statistician (Retired),
National Institute for Occupational Safety and Health, Centers for
Disease Control, Morgantown, West Virginia

John M. Peters, M.D., Professor, and Director, Division of Occupa-
tional Health, Department of Preventive Medicine, University of
Southern California School of Medicine, Los Angeles, California

Richard Peto, M.A., M.Sc., I.C.R.S., Requis Assessor of Medicine,
Radcliffe Infirmary, University of Oxford, Oxford, England, Unit-
ed Kingdom

Philip C. Pratt, M.D., Professor of Pathology, Department of
Pathology, Duke University Medical Center, Durham, North
Carolina

Edward P. Radford, M.D., Visiting Professor, University of Occupa-
tional and Environmental Health, School of Medicine, Yahata
Nishi-Ku, Kitakyushu, Japan

Robert B. Reger, Ph.D., Chief, Epidemiological Investigations
Branch, Division of Respiratory Disease Studies, National Insti-
tute for Occupational Safety and Health, Centers for Disease
Control, Morgantown, West Virginia

Attilio D. Renzetti, Jr., M.D., Professor of Medicine, and Chief,
Division of Respiratory, Critical Care, and Occupational Pulmo-
nary Medicine, University of Utah Health Sciences Center, Salt
Lake City, Utah

E. Neil Schachter, M.D., Professor of Medicine and Community
Medicine, The Mount Sinai School of Medicine, and Director,
Respiratory Therapy, The Mount Sinai Medical Center, The
Mount Sinai School of Medicine of the City University of New
York, New York, New York

Richard S. Schilling, M.D., Department of Occupational Health and
Applied Physiology, London School of Hygiene and Tropical
Medicine, University of London, London, England, United King-
dom

Irving J. Selikoff, M.D., Professor Emeritus, The Mount Sinai School
of Medicine of the City University of New York, New York, New
York

Kyle N. Steenland, Ph.D., Epidemiologist, Industrywide Studies
Branch, Division of Surveillance Hazard Evaluations and Field
Studies, National Institute for Occupational Safety and Health,
Centers for Disease Control, Cincinnati, Ohio

Jesse L. Steinfeld, M.D., President, Medical College of Georgia,
Augusta, Georgia

Arthur C. Upton, M.D., Professor, and Chairman, Institute of
Environmental Medicine, New York University Medical Center,
New York, New York

- John Christopher Wagoner, M.D., F.R.C.(Path), Medical Research Council Pneumoconiosis Unit, Llandough Hospital, Penarth, South Glamorgan, Wales, United Kingdom
- Kenneth E. Warner, Ph.D., Professor, and Chairman, Department of Health Planning and Administration, School of Public Health, The University of Michigan, Ann Arbor, Michigan
- David H. Wegman, M.D., M.S., Professor, Environmental and Occupational Health Sciences, School of Public Health, University of California at Los Angeles, Los Angeles, California
- Hans Weill, M.D., Schlieder Foundation Professor of Pulmonary Medicine, Tulane University School of Medicine, New Orleans, Louisiana
- William Weiss, M.D., Professor Emeritus of Medicine, Hahnemann University, Philadelphia, Pennsylvania
- *R. Keith Wilson, M.D., Associate Professor of Medicine, Pulmonary Section, Baylor College of Medicine and The Methodist Hospital, Houston, Texas
- *Ronald W. Wilson, M.A., Director, Division of Epidemiology and Health Promotion, National Center for Health Statistics, Office of the Assistant Secretary for Health, Hyattsville, Maryland
- James B. Wyngaarden, M.D., Director, National Institutes of Health, Bethesda, Maryland
- Frank E. Young, M.D., Commissioner, Food and Drug Administration, Rockville, Maryland

The editors also acknowledge the contributions of the following staff members and others who assisted in the preparation of this Report.

- Erica W. Adams, Chief Copy Editor and Assistant Production Manager, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland
- Richard H. Amacher, Director, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland
- John L. Bagrosky, Associate Director for Program Operations, Office on Smoking and Health, Rockville, Maryland
- Charles A. Brown, Programmer, Automation and Technical Services Department, Informatics General Corporation, Rockville, Maryland
- Clarice D. Brown, Statistician, Office on Smoking and Health, Rockville, Maryland
- Richard C. Brubaker, Information Specialist, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland
- Catherine E. Burckhardt, Secretary, Office on Smoking and Health, Rockville, Maryland

Joanna B. Crichton, Copy Editor, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Stephanie D. DeVoe, Programmer, Automation and Technical Services Department, Informatics General Corporation, Rockville, Maryland

Terri L. Ecker, Clerk-Typist, Office on Smoking and Health, Rockville, Maryland

Felisa F. Enriquez, Information Specialist, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

James N. Ferguson, Reproduction Technician, Office Services Department, Informatics General Corporation, Rockville, Maryland

Danny A. Goodman, Information Specialist, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Karen Harris, Clerk-Typist, Office on Smoking and Health, Rockville, Maryland

Leslie J. Headlee, Information Specialist, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Patricia E. Healy, Technical Information Specialist, Office on Smoking and Health, Rockville, Maryland

Timothy K. Hensley, Technical Publications Writer, Office on Smoking and Health, Rockville, Maryland

Shirley K. Hickman, Data Entry Operator, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Ayse N. Hisim, Secretary, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Robert S. Hutchings, Associate Director for Information and Program Development, Office on Smoking and Health, Rockville, Maryland

Leena Kang, Data Entry Operator, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Carl M. Koch, Jr., Information Specialist, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Julie Kurz, Graphic Artist, Information Center Management Department, Informatics General Corporation, Rockville, Maryland

Maureen Mann, Editorial Assistant, Office on Smoking and Health, Rockville, Maryland

James G. Oakley, Library Acquisitions Clerk, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Ruth C. Palmer, Secretary, Office on Smoking and Health, Rockville, Maryland

Russell D. Peek, Library Acquisitions Specialist, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Roberta L. Phucas, Secretary, Office on Smoking and Health, Rockville, Maryland

Margaret E. Pickerel, Public Information and Publications Specialist, Office on Smoking and Health, Rockville, Maryland

Raymond K. Poole, Production Coordinator, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Linda R. Sexton, Information Specialist, Health and Natural Resources Department, Informatics General Corporation, Rockville, Maryland

Linda R. Spiegelman, Administrative Officer, Office on Smoking and Health, Rockville, Maryland

Evelyn L. Swarr, Administrative Secretary, Automation and Technical Services Department, Informatics General Corporation, Rockville, Maryland

Debra C. Tate, Publications Systems Specialist, Publishing Systems Division, Informatics General Corporation, Riverdale, Maryland

Jerry W. Vaughn, Development Technician, University of California at San Diego, San Diego, California

Mary I. Walz, Computer Systems Analyst, Office on Smoking and Health, Rockville, Maryland

Louise G. Wiseman, Technical Information Specialist, Office on Smoking and Health, Rockville, Maryland

Pamela Zuniga, Secretary, University of California at San Diego, San Diego, California

TABLE OF CONTENTS

Foreword	vii
Preface.....	ix
Acknowledgments.....	xiii
1. Introduction, Overview, and Summary and Conclusions	1
2. Occupation and Smoking Behavior in the United States: Current Estimates and Recent Trends.....	19
3. Evaluation of Smoking-Related Cancers in the Workplace.....	97
4. Evaluation of Chronic Lung Disease in the Workplace.....	137
5. Chronic Bronchitis: Interaction of Smoking and Occupation.....	179
6. Asbestos-Exposed Workers	195
7. Respiratory Disease in Coal Miners	285
8. Silica-Exposed Workers	319
9. Occupational Exposures to Petrochemicals, Aromatic Amines, and Pesticides	355
10. Cotton Dust Exposure and Cigarette Smoking.....	399
11. Ionizing Radiation and Lung Cancer	441
12. Smoking Intervention Programs in the Workplace.....	473
Index	517